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Intrinsic room temperature ferromagnetism in Co-implanted ZnO

Akdogan N., Nefedov A., Westerholt K., Zabel H., Becker H., Somsen C., Khaibullin R., Tagirov L.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

We report on the structural and magnetic properties of a cobalt-implanted ZnO film grown on a sapphire substrate. X-ray diffraction and transmission electron microscopy reveal the presence of a ( )-oriented hexagonal Co phase in the Al2O3 sapphire substrate, but not in the ZnO film. Co clusters, with a diameter of about 5-6 nm, form a Co rich layer in the substrate close to the ZnO/Al2O3 interface. Magnetization measurements indicate that there exist two different magnetic phases in the implanted region. One originates from the Co clusters in Al2O 3, the other one belongs to a homogeneous ferromagnetic phase with a ferromagnetic Curie temperature far above room temperature. In the latter case, the ferromagnetism can be attributed to Co substitution on Zn sites in the ZnO layer. We have observed magnetic dichroism at the Co L2,3 and O K edges at room temperature as well as the multiplet structure in x-ray absorption spectra around the Co L3 edge, supporting the intrinsic nature of the observed ferromagnetism in a Co-implanted ZnO film. The magnetic moment per substituted cobalt is found to be about 2.81 νB, which is very close to the theoretical expected value of 3 νB/Co for Co 2+ in its high spin state. © 2008 IOP Publishing Ltd.

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